Article

Socioeconomic factors to improve production and marketing of the pecan nut in the Comarca Lagunera

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Abstract

In the Comarca Lagunera 9 957 ha have been established with pecan walnut, with the region being the third in national importance. The studies of socioeconomic type in walnut in Mexico are mainly descriptive, studies that analyze the relationships between the different variables of the crop that allow making recommendations to boost their growth are required. The objective of this work was to analyze the relationship between various socioeconomic factors such as garden size, training and financing with variables such as yields, price, gross income, infrastructure for harvesting and sale of selected nuts. To obtain the information, a survey was applied during 2014 to a sample of 27 orchards distributed throughout the region. The data were analyzed by Analysis of Variance of a factor to compare the means of the groups: orchards that receive vs those that do not receive training, orchards that receive vs those that do not receive financing; and orchards of up to three hectares vs. more than three hectares. Differences were found in variables such as yields per hectare, price of walnut, sale of selected walnut, infrastructure for commercialization and income. To improve the situation of the walnut orchards in the Comarca Lagunera, it is recommended to strengthen the training and financing, particularly of the small producers and the importance of the size of the orchard, to look for forms of organization to achieve economies of scale in the production and commercialization of the pecan nut in the Comarca Lagunera.

Keywords: financing, orchard size, training, walnut.

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Introduction

The pecan nut (*Carya illinoensis* Koch.) is native to northern Mexico and southeast of the United States of America (Gray, 1973). For many years, walnut was one of the main foods of American Indians (Tait, 1996). It is currently used to make a wide variety of products such as sweets, jams, pies, cakes, cookies, ice cream, snow, ingredient for gourmet cooking and traditional cuisine (COMENUEZ, 2017). It maintains a strong competition in the market with substitute nuts such as almond, walnut 'nuez de castilla' and hazelnut 'avellana' (COMENUEZ, 2017).

The world production of pecan nuts in the 2016-2017 cycle was 118 200 t (peeled base). Mexico is the world's largest producer of pecan nuts with a total of 58 970 t (peeled base), representing 50% of world production, followed by the United States of America with 52 400 t, representing 44% of the total, both countries participate, together, with 94% of world production (INC, 2018). In Mexico, the states of Chihuahua, Sonora, Coahuila and Durango stand out in nut production with relative shares of 63.14%, 13.39%, 10.83% and 5.74%, respectively (SIAP, 2018).

Mexico is the world's leading exporter with an amount of 34,882 t (peeled base) representing 63% of the total followed by the United States of America with 35% (INC, 2018). In the United States of America, the states of Georgia, New Mexico, Texas, Arizona and Oklahoma stand out with 36.4%, 31.30%, 12.93%, 9.52% and 4.76%, respectively (USDA-NASS, 2018). Faced with the growing demand for walnuts at the global level promoted by China and the increased competition from producer states in Mexico and other countries, it is necessary to improve the production of the Comarca Lagunera and maintain the competitiveness of the region.

However, there are no studies that indicate the factors that need to be strengthened to boost production in the region. It is based on the hypothesis that there are several socioeconomic factors such as training, financing and the size of the garden that directly impact variables such as yields, price, gross income, infrastructure for harvesting and marketing. The Comarca Lagunera, composed of ten municipalities in the northeast of the state of Durango and five in the southwest of the state of Coahuila, contributes 9.5% of the national nut production (SAGARPA-LAGUNA, 2018).

The first plantations of the walnut in the Comarca Lagunera were established in 1948 and the introduced varieties were Western, Wichita, Burkett, San Saba improved, Stuart, Barton and Mahan, predominating the first two (Medina and Cano, 2002). Despite its importance, in Mexico there is very little socioeconomic research in this crop and what exists is a descriptive type. Some are characterization studies of producers (Orona *et al*., 2006; Luna *et al.*, 2013; Orona *et al.*, 2013; Cervantes *et al.*, 2018), others are profitability studies (Lopez *et al*., 2011; Retes *et al*., 2014) and strategic planning (Ojeda *et al*., 2010). It is necessary to carry out inferential explanatory studies that allow identifying factors that are related to variables such as income, income, infrastructure and marketing.

In agriculture, as in other economic activities, technological developments are constantly emerging that allow increasing productivity. One way to get these developments to farmers is training. According to Nakano *et al*. (2018) training is an effective method to disseminate new technologies, increase productivity and reduce rural poverty. Given that the training has a high cost, the challenge

for these authors is to choose the best method at the lowest cost to bring the knowledge to farmers (Nakano *et al.*, 2018). Roco *et al*. (2012) identified training as a factor that influences the adoption of agricultural practices for soil and water conservation.

For their part, Pan and Zhang (2018) state that training in the use of fertilizers is a prerequisite for their scientific management, avoiding excessive applications. One of the dissemination methods followed by international organizations is the preparation of training manuals to improve the productivity and quality of farmers' products (FAO, 2015). Baloch and Thapa (2016) assert that the increase in yields depends on many factors, but in particular training increases skills to improve productivity. They affirm that in addition to the extension there are other factors that influence the yields, highlighting the availability of financing to acquire the inputs, availability of labor and the size of the farm.

Similarly, Wossen *et al*. (2017) indicate that there is a positive and significant effect of training in technology adoption and family welfare, asserting that the impact is greater when producers have access to formal financing.

The lack of financing is one of the main limitations for the modernization of agriculture, Juarez *et al*. (2005) state that financing is of cardinal importance in economic policy to increase production and productivity of the various sectors of the economy and to achieve social welfare. Guirkinger and Trivelli (2006); Cieza (2012) argue that limitations in financing hinder the development of agriculture. On the other hand, Chen *et al*. (2015) have found that commercial banks have little participation and low interest in financing agriculture, so financing, in terms of provision of inputs and services, comes mainly from the value chain itself.

In that same sense, Trzeciak-Duval (2003) indicates that for the banking sector to have a greater participation in the economy, it requires favorable macroeconomic conditions, highlighting stability in inflation and in the currency. Tiffen (2006) mentions that there is also the problem of the culture of non-payment, which is coupled with the absence of incentives for private banks to finance agriculture. Kopparthiy and Kagabo (2012) argue that access to credit is necessary to acquire inputs, as a way to increase productivity and eradicate poverty.

Another factor of importance in the determination of yields and income is the size of the farm, in our case the size of the garden. Campos and Chaves (2012) assert that some of the weaknesses of the agrarian sector are the dispersion of supply and the small size of farms. Therefore, they propose the figure of cooperatives in order to concentrate production and obtain economies of scale. Van *et al*. (1995) found that large farms tend to make greater use of capital-intensive technologies and have higher management skills, while small ones are labor-intensive, so the former can achieve economies of scale by reducing the costs of production.

In this same sense Sheng *et al*. (2014) found that larger units have higher productivity, but not by scale but by changes in production technology. As can be seen, it has been found in various countries and crops that the variables of training, financing and scale of production have an influence on the results of agricultural enterprises. However, in Mexico, in the cultivation of walnut, the existing studies do not address these aspects beyond the descriptive analysis.

The objective of this work was to analyze the relationship of various socioeconomic factors such as training, financing and the size of the garden and its relationship with variables such as yields, price, gross income and infrastructure in the cultivation of walnut and propose measures of public policy to encourage its growth.

Materials and methods

The Comarca Lagunera is located in North-Central Mexico. It is composed of ten municipalities of the Northeast region of the state of Durango and five of the southwest of the state of Coahuila. It is located at an average altitude of 1 139 meters above sea level, a dry desert climate or warm steppe with summer rains and cool winters; the average annual rainfall is 258 mm and the average temperature is 22.1 °C, with ranges of 38.5 °C as the maximum average and 16.1 °C as the minimum average (García *et al*., 2009).

To obtain the information, a survey was applied in 2014 to a random sample of 27 gardens distributed in the municipalities of Francisco I. Madero, San Pedro de las Colonias, Torreón and Matamoros, in the state of Coahuila and in Tlahualilo, Gómez Palacio, Lerdo, Nazas and Rodeo of the state of Durango. The sample was taken from the pattern of walnut producers obtained from the Local Plant Health Board of SAGARPA. The questionnaire was composed of 23 questions, divided into the following blocks: general characteristics of the garden, technological aspects of the management of the garden, training received, infrastructure available, financing for production and marketing, organization of producers and marketing.

Simple random sampling (Fuller, 2009) was used to calculate the sample.

$$n= \frac{t^2_{\alpha/2}\, S^2}{d^2 + \frac{t^2 S^2}{N}}$$

Where: n= sample size; t= 1.96 with α= 0.05; S^2= 13 022 is the variance obtained from data from a previous sample of the price variable of the nut to the producer; d= 1.5 is the level of precision of the estimate or the distance desired by the researcher who, at most, moves away from the reference variable, in this case the producer price and N= population size (396 orchards). The calculation of the sample was 21 questionnaires; however, 27 were applied to improve the level of precision of the results.

The data were analyzed using the one-way analysis of variance. The following factors were used as factors: 1) training (receives vs. does not receive training); 2) financing (receives vs does not receive financing); and 3) the size of the garden. In the latter case, two strata were managed: a) up to three hectares; and b) more than three hectares. These strata are the ones that, according to field extension technicians and inferential statistics, showed that they made the difference between the variables analyzed. Of the 27 questionnaires applied, 16 went to orchards of up to three hectares and 11 to orchards of more than 3 ha. Following the stratified sampling, this keeps proportionality with the pattern of orchards of the Comarca Lagunera where 63% are up to 3 ha and 37% more than three hectares, with a small difference in relation to the sample due to adjustments at the time of work of field.

According to Lind *et al*. (2004) and Levin and Rubin (2010) when the samples are small (less than 30 observations) it is recommended to use the student's 't' statistic with (n_1+n_2)-2 degrees of freedom, where n_1 and n_2 are the sizes of the two samples and since the information was obtained by means of a survey, a maximum significance level α= 0.1 was used (Kazmier, 1998). The calculations were made in the statistical package SPSS version 20.0.

Results and discussion

According to the theory, variables such as training, financing and the size of the garden are determining factors for aspects such as yield, sale price, marketing method, infrastructure and income, among others. The results of the analysis for the walnut in the Comarca Lagunera are presented below.

Training

Table 1 shows the results of the analysis of variance according to the training factor. In general, it is observed that the price ($p< 0.1$), the proportion of walnut sold in bulk selected ($p< 0.01$) and the infrastructure ($p< 0.05$) differ depending on whether the producers received training or not in all cases exceeding the nut producers that did receive it. It should be mentioned that the training received by the small producers was basically in pests by technicians of the Local Board of Plant Health, while the medium and large producers hired private technical assistance that included not only pests but also irrigation, pruning, fertilization, classification of the nut and mechanical harvest.

In the cases of income and income, those that received training have higher values but without significance derived mainly from the high variability in the variables. In the case of yields, the producers who received training exceeded by 430 kg ha^{-1} those who did not receive it and although the difference was not significant, that amount represents almost a third of the average yield of a typical orchard in the region. Regarding income, those who received training had an additional income of $9 720.00 ha^{-1} which from the economic point of view, represents more than 25% of production costs per hectare.

In general, the results coincide with several authors who highlight the importance of training. Wossen *et al*. (2017) found that the training improves the technology adoption, productivity and income of the producers although they identified other factors that have additional influence such as access to credit, education, age and the size of the property. Roco *et al*. (2012) also agree on the importance of this factor when stating that, for each training activity, the probability of adopting the technologies increases 35.1% in an average farmer.

Pan and Zhang (2018) found that training in the use of fertilizers increased knowledge about their management by 40%. Nakano *et al*. (2018); Baloch and Thapa (2016) found higher yields in the orchards of producers who received training, but also observed that over time the difference in productivity was extended in comparison with those that were not trained. Orona *et al*. (2006), in a work on walnut in the Comarca Lagunera, suggested training specifically in pest and disease management and the use of efficient irrigation systems.

These results highlight the importance of training for the process of technology adoption and income improvement. However, in this work it was found that training not only influences the adoption of field technological practices, but also variables such as the sale of selected nuts and the acquisition of harvesting tools (Table 1).

Table 1. Comparison of means between training and selected variables.

Variables	Are you receiving training?	N	Mean	Standard deviation	Significance
Yield (t ha^{-1})	Yes	14	1.5758	0.85106	0.137
	Not	13	1.1457	0.55999	
Weighted sale price of walnut ($ kg^{-1})	Yes	14	44.1538	13.81482	0.08
	Not	13	36.8358	5.71968	
Proportion of walnut sold in bulk selected (%)	Yes	14	53.5714	48.92807	0.001
	Not	13	0	0	
Infrastructure (number of implements for the harvest)	Yes	14	1.1429	1.65748	0.046
	Not	13	0.1538	0.37553	
Gross income ($ ha^{-1})	Yes	14	59282.6129	36494.42209	0.418
	Not	13	49562.2	22605.36474	

Financing

Table 2 shows the comparison of means of selected variables for those producers that received or not financed.

Table 2. Comparison of means between financing to produce and selected variables.

Variables	Do you receive financing to produce?	N	Mean	Standard deviation	Significance
Yield (t ha^{-1})	Yes	5	2.22	0.7328	0.003
	Not	22	1.1752	0.61064	
Weighted sale price of walnut ($ kg^{-1})	Yes	5	40.42	6.23554	0.989
	Not	22	40.3455	11.79373	
Proportion of walnut sold in bulk selected (%)	Yes	5	96	8.94427	0
	Not	22	12.2727	32.06122	
Infrastructure (number of implements for the harvest)	Yes	5	2	2.34521	0.008
	Not	22	0.3636	0.72673	
Gross income ($ ha^{-1})	Yes	5	91530	38728.9233	0.001
	Not	22	46209.7809	21508.96406	

Funding was highly significant ($p< 0.01$) for four of the five variables analyzed: yields, nut traded in a selected form, infrastructure and income. These results are consistent with what is expected since a producer with resources is able to acquire and timely apply the fertilizers and supplies necessary for the proper development of walnut trees. The yields of the orchards of producers with financing exceed in more than one ton (88%) the orchards without the necessary economic resources.

These results coincide with Dong *et al*. (2010) who found that, by eliminating restrictions on access to credit, productivity increased 31.6% while household income increased 23.2%. Kopparthiand and Kagabo (2012) found a high correlation between those producers who had access to financing and their levels of production and income. Guirkinger and Boucher (2007) found that by reducing restrictions on access to credit, production per hectare increased 26%. Cervantes *et al*. (2018) found in walnut in the Comarca Lagunera, that producers with greater availability of financing obtained higher yields.

They found that of the orchards between 1 and 10 ha, only 9.1% received bank financing and obtained a yield of 1.2 t ha^{-1}; while the orchards between 45 and 100 ha received 100% credits and obtained a yield of 2.4 t ha^{-1}. The percentage of walnut marketed in a selected way also increased significantly ($p< 0.01$), 96% against 12.27% of those who sell it without selecting which is because the producer has the necessary resources to hire personnel for that purpose. Likewise, having more resources allows you to acquire more implements for marketing ($p< 0.01$) such as the vibrator, breaker, sorter, cellar, etc. so that it can better market its harvest, hence the gross income of producers who have financing almost double those who do not have it ($p< 0.01$) (Table 2).

Orchard size

In the Table 3 shows the comparisons of means of different variables according to the garden size factor. It was observed that the price of the walnut ($p< 0.1$), the percentage of walnut sold in bulk in selected form ($p< 0.05$) and the infrastructure for the harvest ($p< 0.01$) differ according to the size of the orchard.

Table 3. Comparison of means between the size of the garden and selected variables.

Variables	Size of orchard	N	Mean	Standard deviation	Significance
Yield (t ha^{-1})	Up to 3 ha	16	1.2903	0.72606	0.52
	More than 3 ha	11	1.4827	0.79227	
Weighted sale price of walnut ($ kg^{-1})	Up to 3 ha	16	37.375	5.16236	0.085
	More than 3 ha	11	44.7	15.25444	
Proportion of walnut sold in bulk selected (%)	Up to 3 ha	16	12.5	34.1565	0.027
	More than 3 ha	11	50	48.78524	
Infrastructure (number of implements for the harvest)	Up to 3 ha	16	0.125	0.34157	0.006
	More than 3 ha	11	1.4545	1.75292	
Gross income ($ ha^{-1})	Up to 3 ha	16	47126.5294	23570.02509	0.126
	More than 3 ha	11	65476.4282	36816.83958	

In general, the larger garden size, the prices, the selected nut sale and the infrastructure improve. The above coincides with Cervantes *et al*. (2018) who found that 'producers with a larger garden size have fixed traders; while the rest is subject to buyers who offer a certain price for the product; commercial uncertainty is strongest in smaller-sized orchards'. Campos and Chaves (2012); Ayala *et al*. (2008) affirm that one way to better sell the products of the field is to organize into cooperatives in order to integrate larger volumes of production and negotiate better prices.

For the variables yield and gross income, although the difference between means was not significant, in the case of yields, production, on average, was almost 200 kg in favor of the large orchards (15% of the average yield of an orchard). This coincides with Mamudu (2016) who found a positive relationship between farm size and productivity which was higher than 10% in the case of large farms. Also Abate *et al*. (2014) also found that by organizing cooperatives and producing on a larger scale, productive efficiency increases due to greater access to inputs and extension services.

In the case of income, more than \$18 000.00 ha^{-1} was obtained in favor of the large orchards, which for the nut producers is significant if we consider that the cost of production per hectare is approximately \$35 000.00, so this difference represents more than 50. Some authors such as Sheng *et al*. (2014) found higher income in large farms; however, they affirm that success depends on these farms having financing, human capital and training. According to Orona *et al*. (2006) the walnut producers in the Comarca Lagunera with smaller orchards are those of the common sector, who require greater support in terms of financing and training.

Conclusions

Receiving training is a significant factor in the variables of sales price, proportion of walnut sold in bulk and infrastructure for marketing. In the cases of the means of yield and income per hectare, they were also higher for orchards that received training, although without being significant, but of economic importance for the producers.

The most important factor was financing. In four of the five contrast variables, highly significant statistical differences were found, highlighting sufficient and timely resources to have a better management of the orchard, which in this case was reflected in a yield that almost doubles that of those orchards without financing. The orchards that received financing presented higher revenues, better infrastructure and higher percentage of walnut sold in a selected way. The orchards of size superior to 3 has, registered superior values in the sale price, the proportion of walnut commercialized in bulk of form selected and the infrastructure for commercialization. The means of yield and income per hectare were also higher for large orchards, although without being statistically significant.

The relevance of the size of the orchard makes it possible to recommend to the small ones, who need to organize themselves to achieve economies of scale, to make consolidated purchases of inputs and to increase the negotiation capacity in the sale of walnuts. The results obtained from the

orchards that received training and financing make it possible to recommend to public institutions and producer organizations to strongly promote training and obtaining financing, especially for small producers, which will result in higher nut yields, an increase in the sale price and in better income for the producers.

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